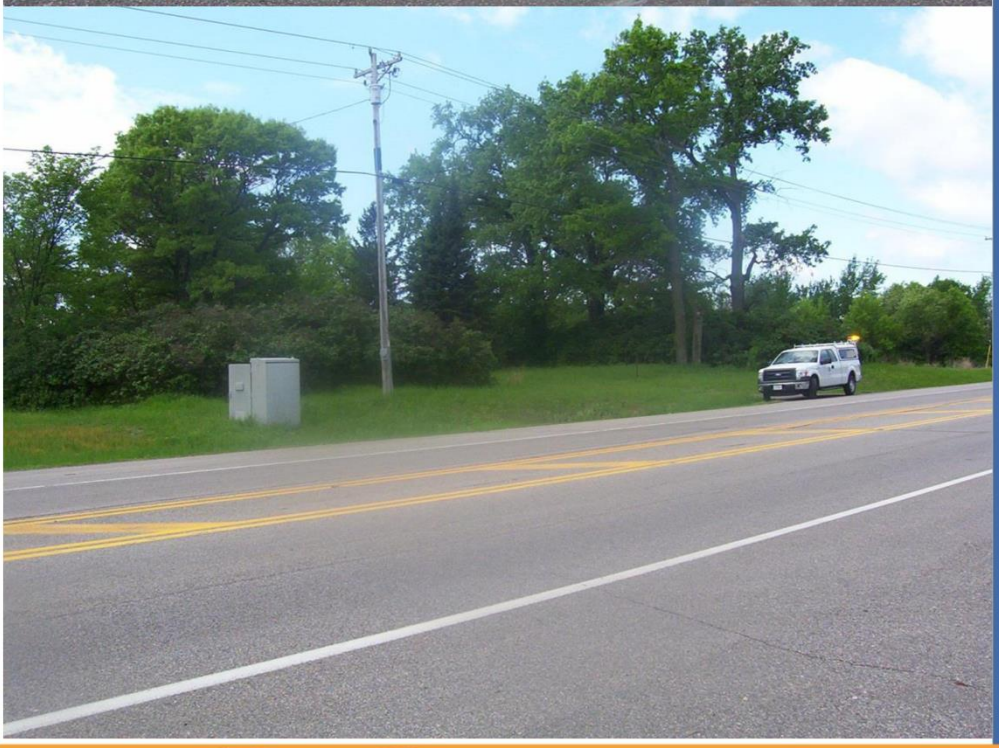
AUGUST 2019



WIM #45
CSAH 14, MP 10.1
BLAINE, MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #45 is located on CSAH 14 near Blaine in Anoka county.

System Operation

WIM #45 was operational for the entire month of August 2019. Volume was computed using all monthly data.

System Calibration

WIM #45 was most recently calibrated on 2016-01-19. Table 1 summarizes the front axle weights of class 9s by lane [1]. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation [2]. Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

Summary of Volume Statistics

Total Monthly Volume: 416566 | Passenger Vehicles: 405520 | Heavy Commercial Vehicles: 11046

Monthly Average Daily Traffic (MADT): 13437 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 356

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. EB vehicles typically reached highest volume levels on Wednesdays, with lowest volumes reported on Sundays. WB vehicles typically reached highest volume levels on Wednesdays, with lowest volumes reported on Sundays (see Figure 3 and 4).

Passenger Vehicles (PVs)

Volume trends. On an average 24-hour day (see Figure 5), EB PVs generally reached peak volume levels between 07 AM and 05 PM. Similarly, WB PVs peaked in volume between 03 PM and 05 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling EB typically reached peak volume levels between 07 AM and 05 PM, while volume going WB peaked between 03 PM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 5's and Class 6's.

Overweight HCVs

Volume trends. Of a total of 11046 HCVs, 932 of them were overweight [3]. These overweight HCVs contributed to 0.2% of total monthly volume, and 8.5% of total monthly

HCV volume. EB overweight vehicles typically reached highest numbers on Thursdays, with lowest volumes reported on Sundays. WB overweight vehicles tended to reach highest volumes on Mondays, with lowest volumes reported on Sundays. See Figure 3 .
The top two overweight violators by class were the class 6 and class 9 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 51.1% of all overweight vehicles traveling EB this month (see Figure 7 & 8). Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in June.
WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report [4].
Using normal load limits ,42 EB vehicles exceeded 88,000 pounds (21 vehicles were Class 10's; 17 vehicles were Class 13's). Of vehicles traveling WB,

44 EB vehicles exceeded 88,000 pounds (17 vehicles were Class 10's; 14 vehicles were Class 13's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from August 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in August 2019. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling EB, while there were more fully_loaded Class 9's than empty traveling WB. Data also suggests that there were more fully_loaded Class 10's than empty traveling in the EB direction. In the WB direction, there were more fully_loaded class 10 vehicles.

Freight Totals. A total of 69070 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (51%) than WB (49%). See Table 4 and Figure 11 for more freight information.

####**Infrastructure Considerations Bridge.** Bridge No. 02051 (a prestressed concrete beam span) is approximately 2.8 miles west of WIM #45 on CSAH 14, and Bridge No. 02006 (a prestressed concrete beam span) is approximately 5.2 miles east of WIM #45 on CSAH 14. WIM #45 recorded a total of 416566 vehicles with a combined GVW of 2132353 kips (1 kip = 1,000 pounds = 0.5 tons) in August 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 5532 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 50.4% of all ESALs were recorded EB while 49.6% was observed WB. In particular, 23% of all ESALs were generated by the Class 6's (Class 6's were also responsible for generating 3% of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

#####WIM monthly reports can be found at: http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html MnDOT's vehicle classification scheme and vehicle class groupings for traffic forecasting can be found at: http://www.dot.state.mn.us/traffic/data/data-products.html#weight

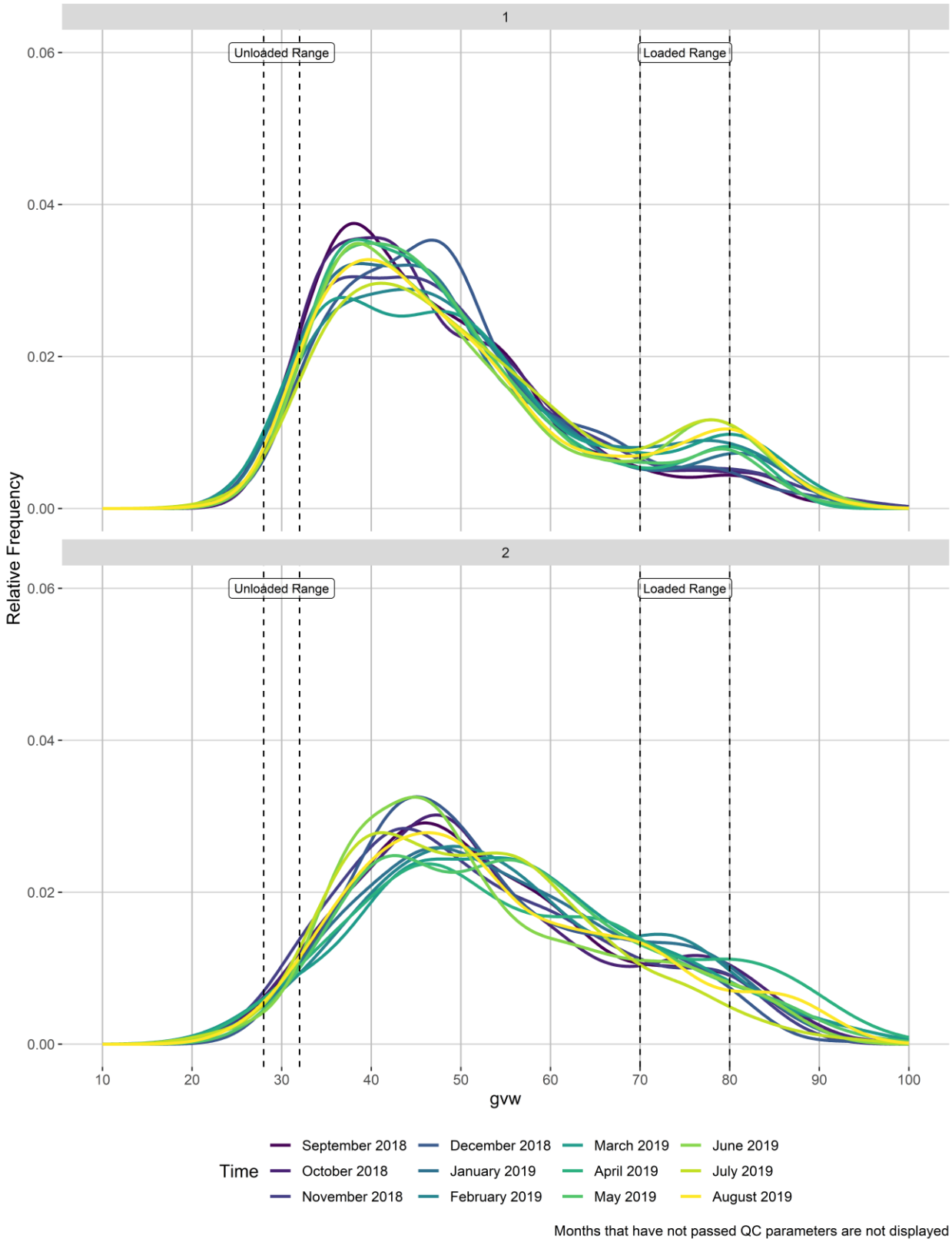
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values

- [2] Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.

- [3] An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes: http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp

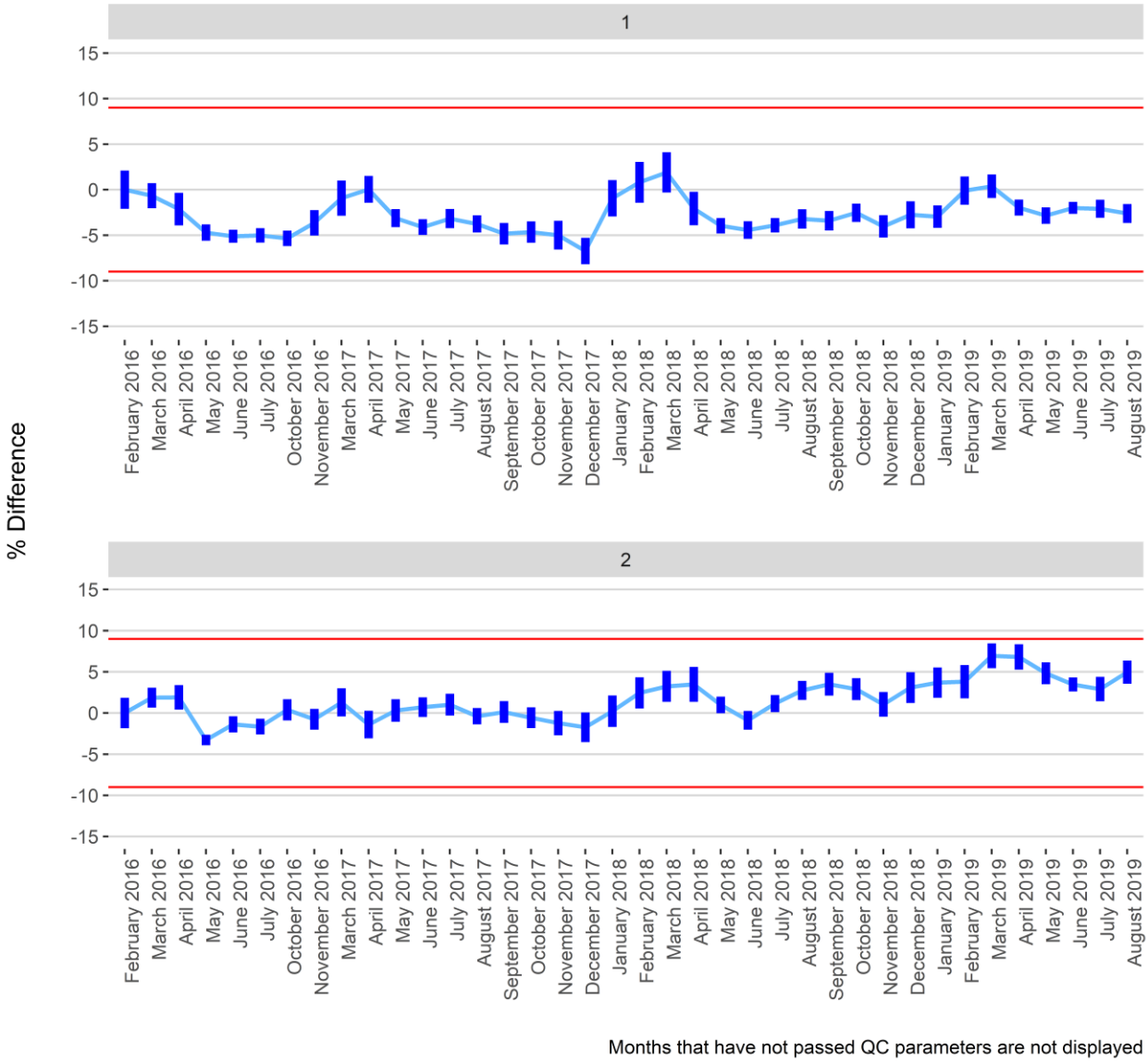
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

Figure 1 - Monthly Class 9 GVW Histogram



Months that have not passed QC parameters are not displayed

Figure 2 - Percent Difference of Front Axle Weight from Last Calibration (+/- 95% CI)



Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume vs. Day of the Week

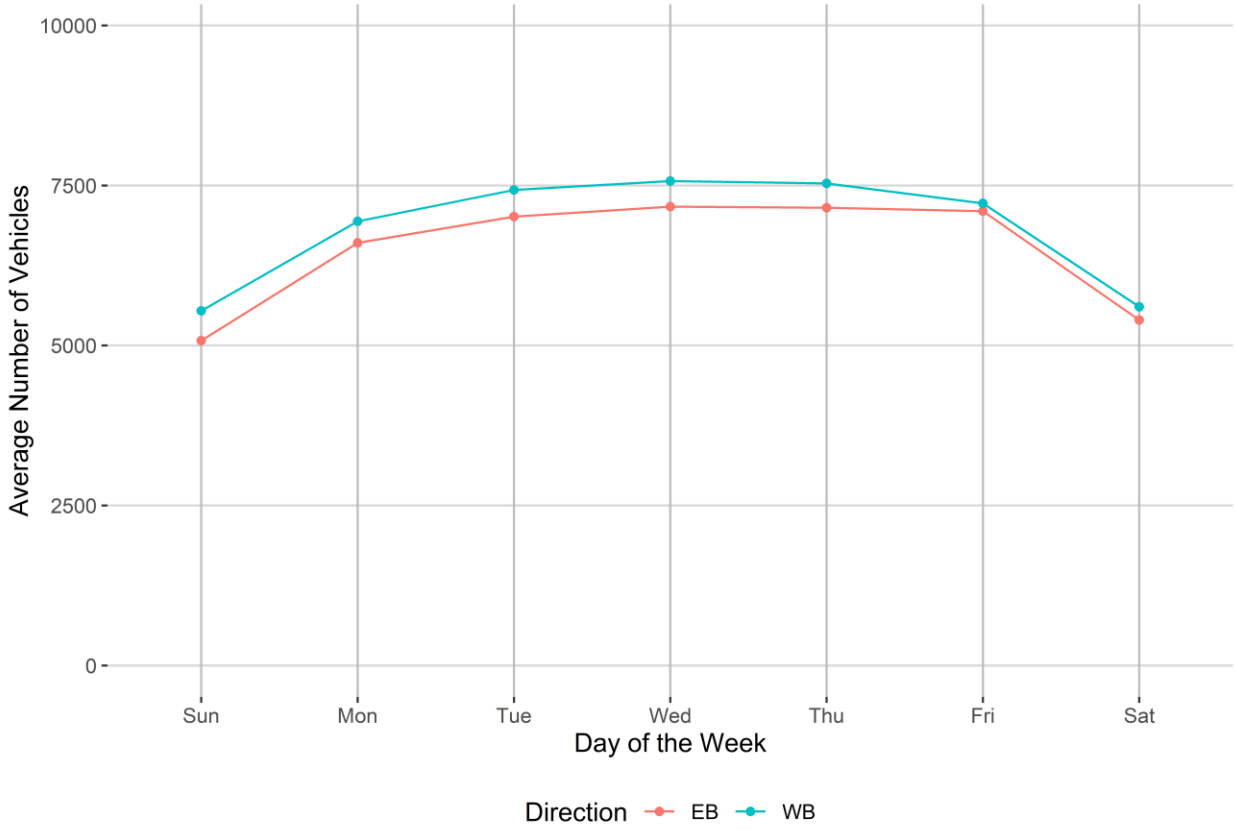


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

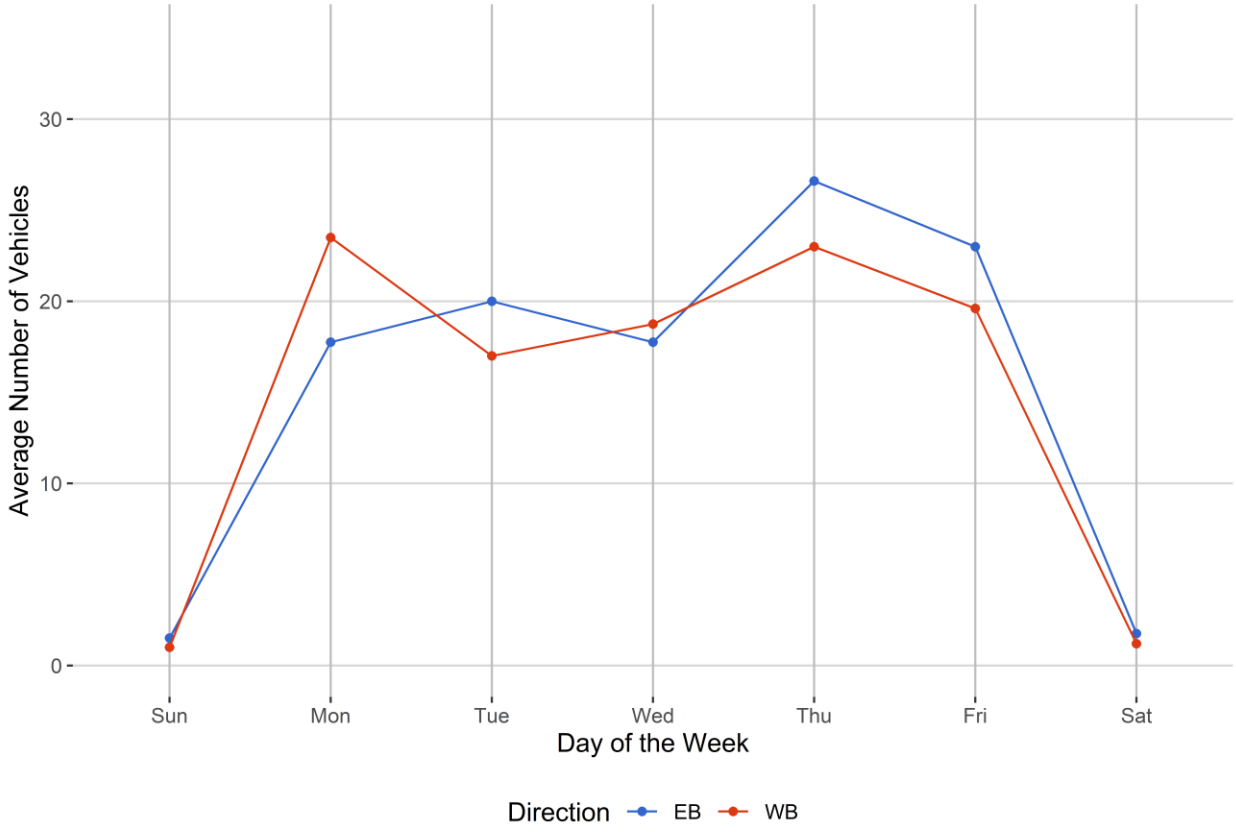


Figure 4 - Passenger Vehicles
vs. Hour of the Day

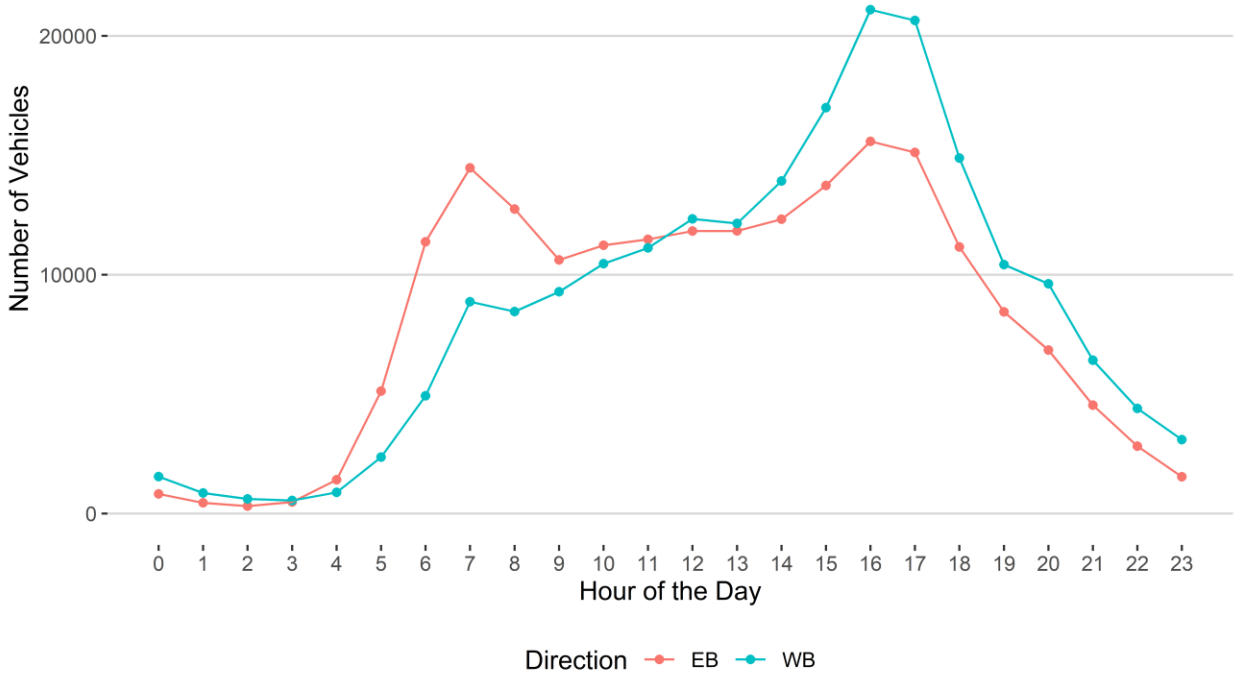


Figure 5 - Heavy Commercial Vehicles
vs. Hour of the Day

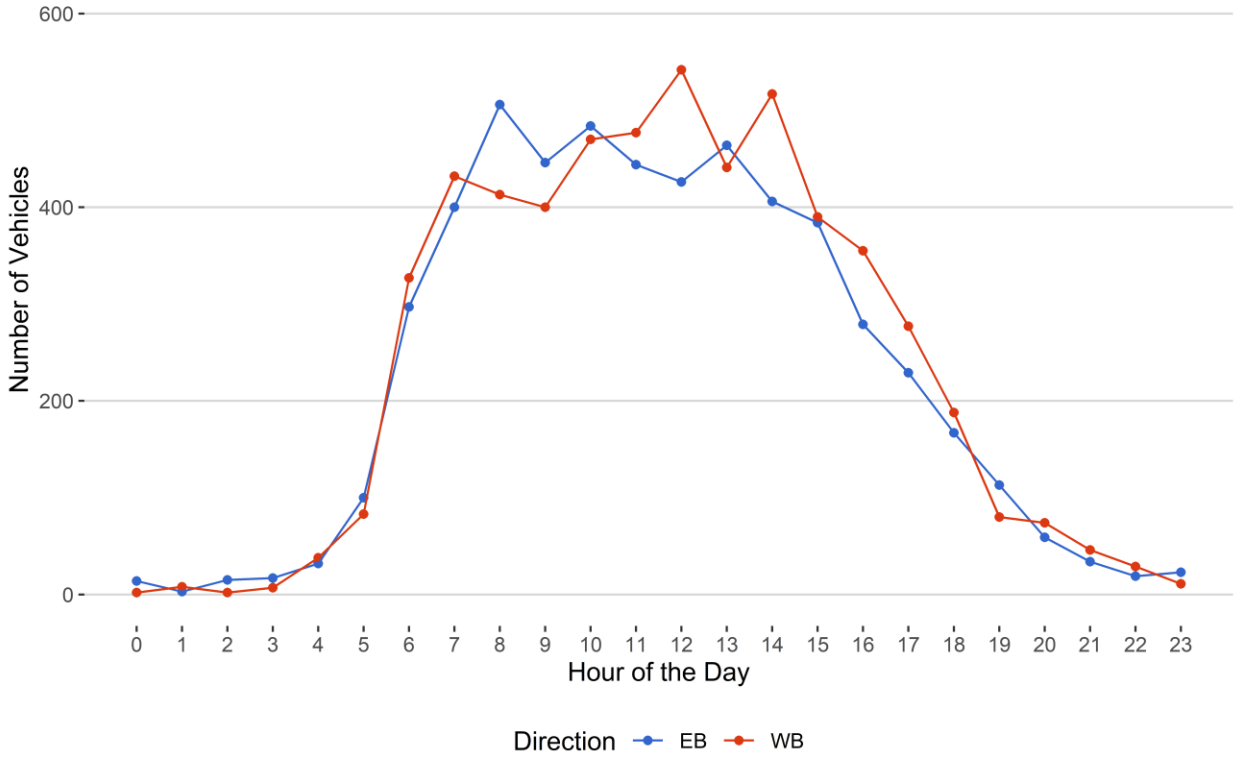


Figure 6 - Overweight Vehicles by Class
vs. Hour of the Day

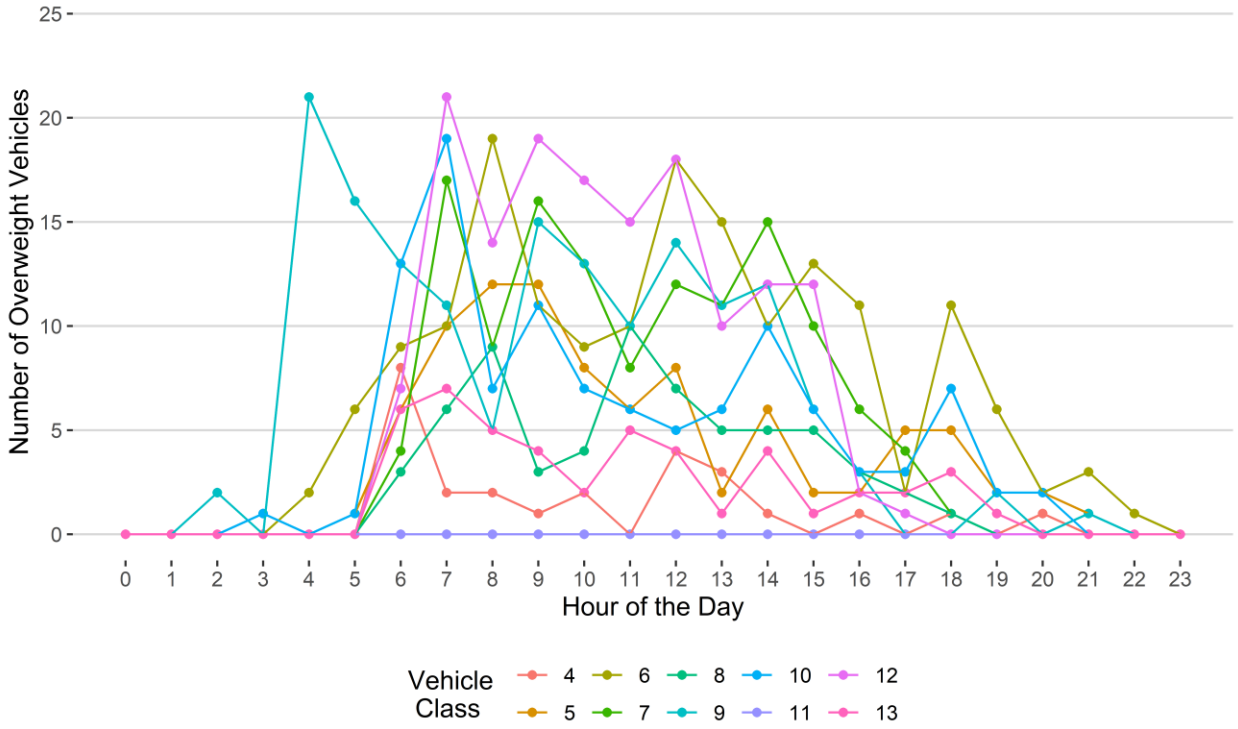


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

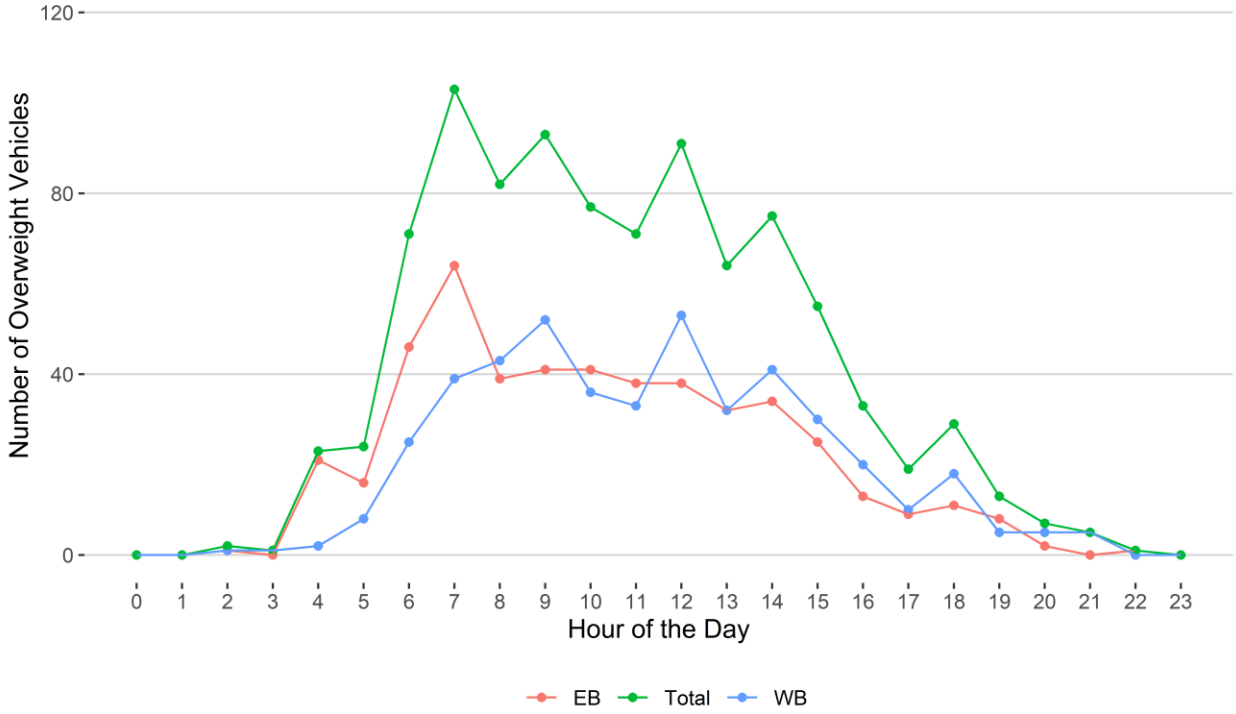
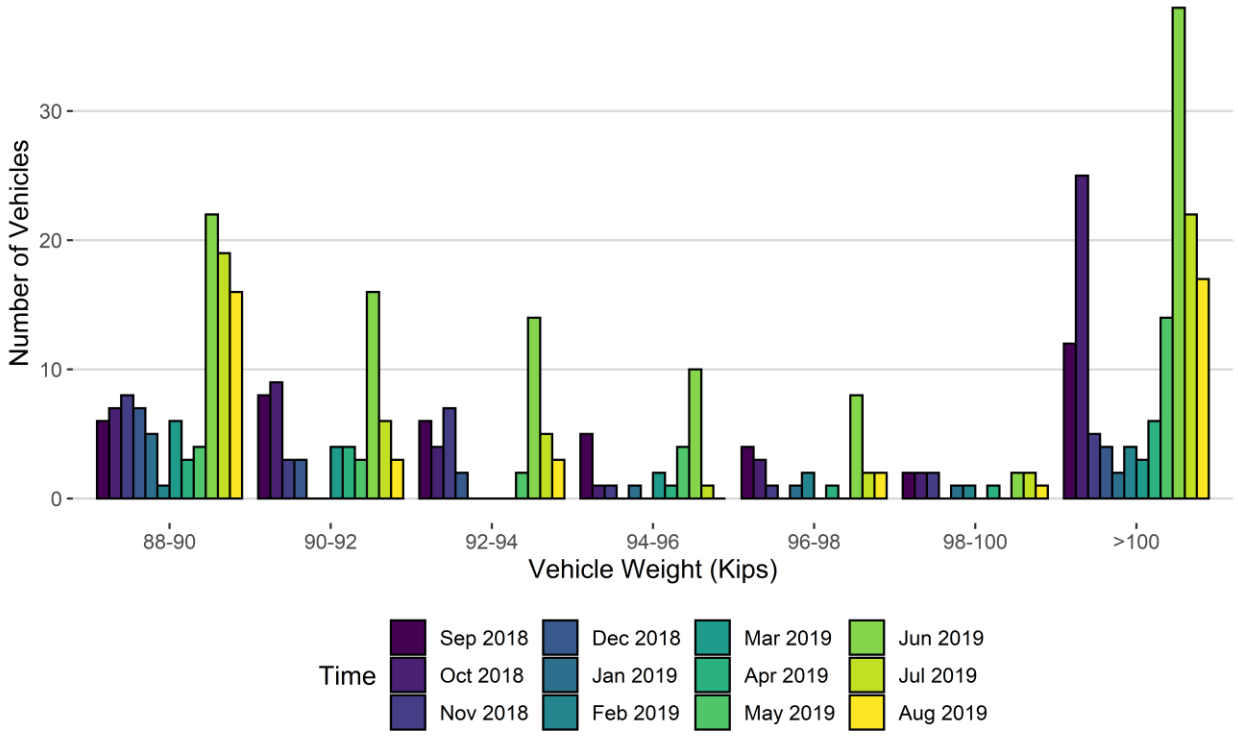
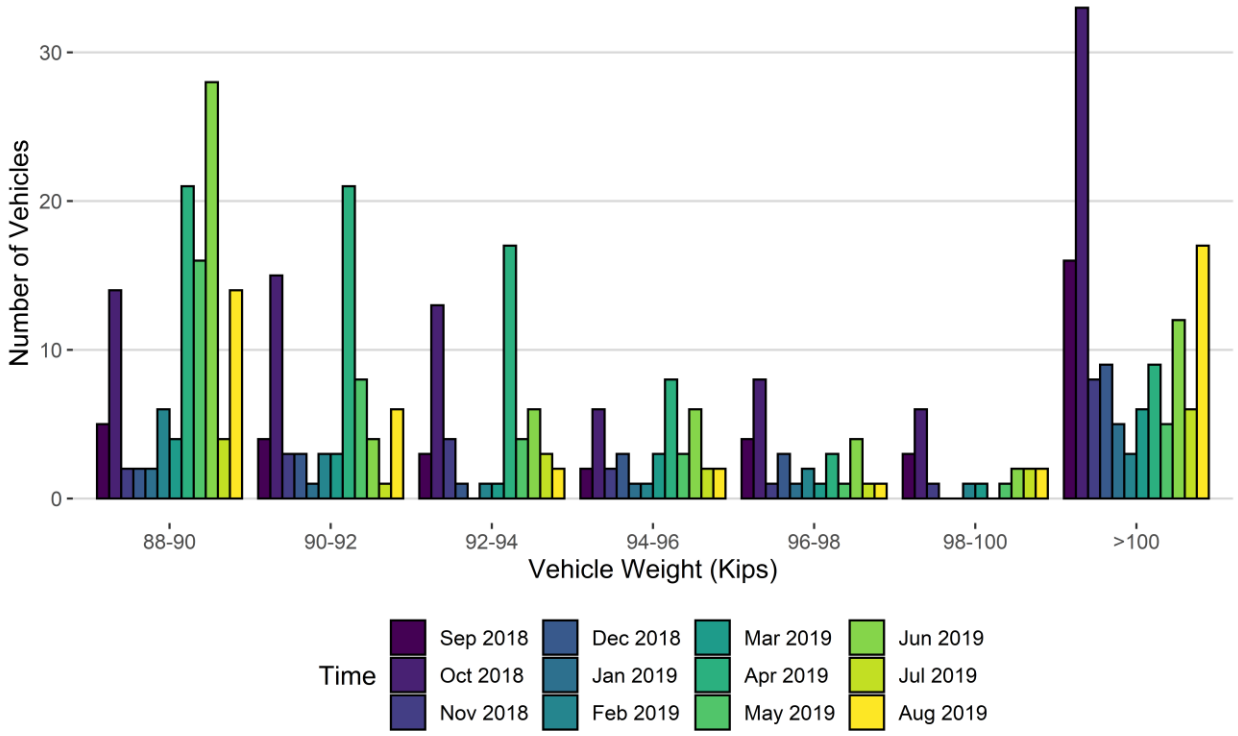


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Sep 2018*	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*	*Jun 2019*	*Jul 2019*	*Aug 2019*
88-90	6	7	8	7	5	1	6	3	4	22	19	16
90-92	8	9	3	3	0	0	4	4	3	16	6	3
92-94	6	4	7	2	0	0	0	0	2	14	5	3
94-96	5	1	1	0	1	0	2	1	4	10	1	0
96-98	4	3	1	0	1	2	0	1	0	8	2	2
98-100	2	2	2	0	1	1	0	1	0	2	2	1
>100	12	25	5	4	2	4	3	6	14	38	22	17
Total	43	51	27	16	10	8	15	16	27	110	57	42

Figure 8 - Histogram of WB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Sep 2018*	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*	*Jun 2019*	*Jul 2019*	*Aug 2019*
88-90	5	14	2	2	2	6	4	21	16	28	4	14
90-92	4	15	3	3	1	3	3	21	8	4	1	6
92-94	3	13	4	1	0	1	1	17	4	6	3	2
94-96	2	6	2	3	1	1	3	8	3	6	2	2
96-98	4	8	1	3	1	2	1	3	1	4	1	1
98-100	3	6	1	0	0	1	1	0	1	2	2	2
>100	16	33	8	9	5	3	6	9	5	12	6	17
Total	37	95	21	21	10	17	19	79	38	62	19	44

Figure 8 - Class 9's and 10's by Direction vs Gross Vehicle Weight

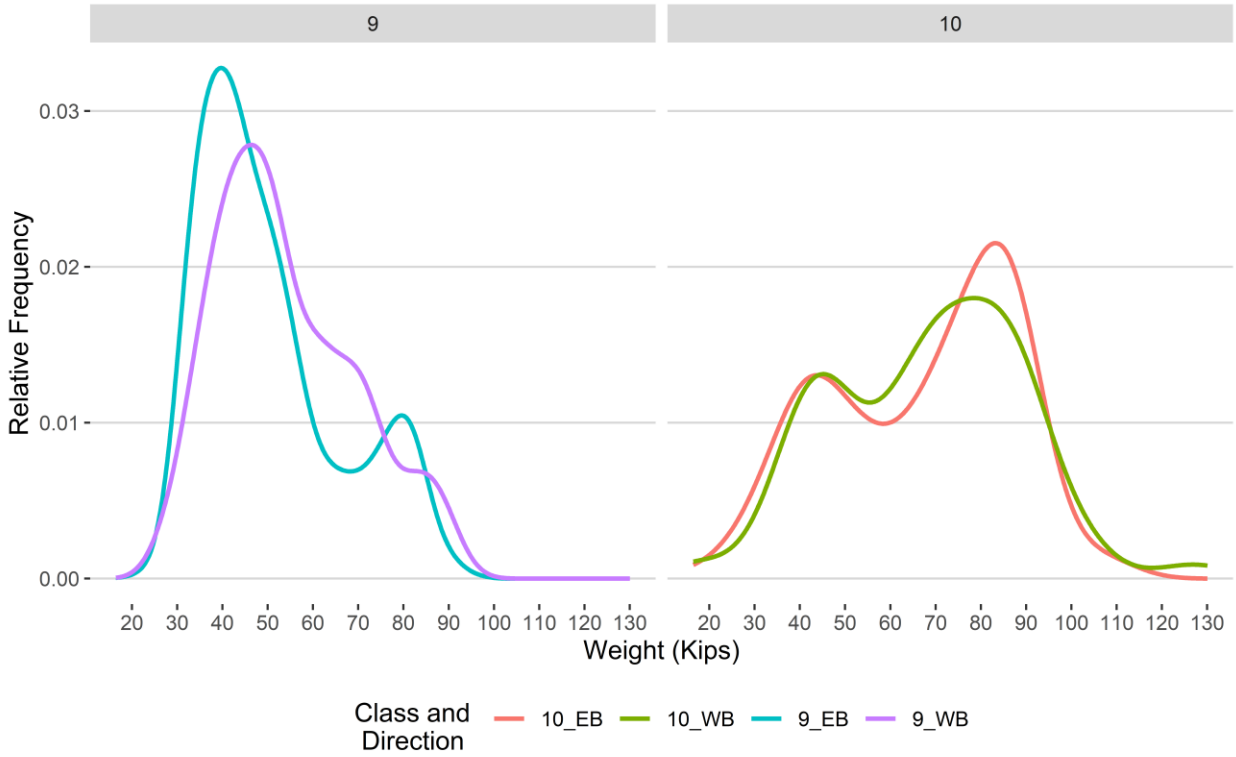


Figure 9 - Freight Percentage by Direction and Class

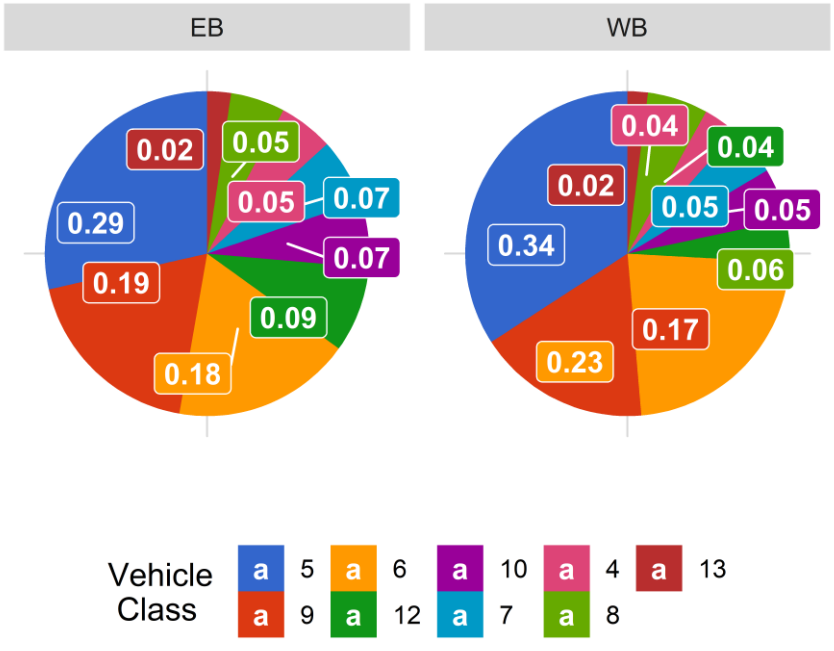


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

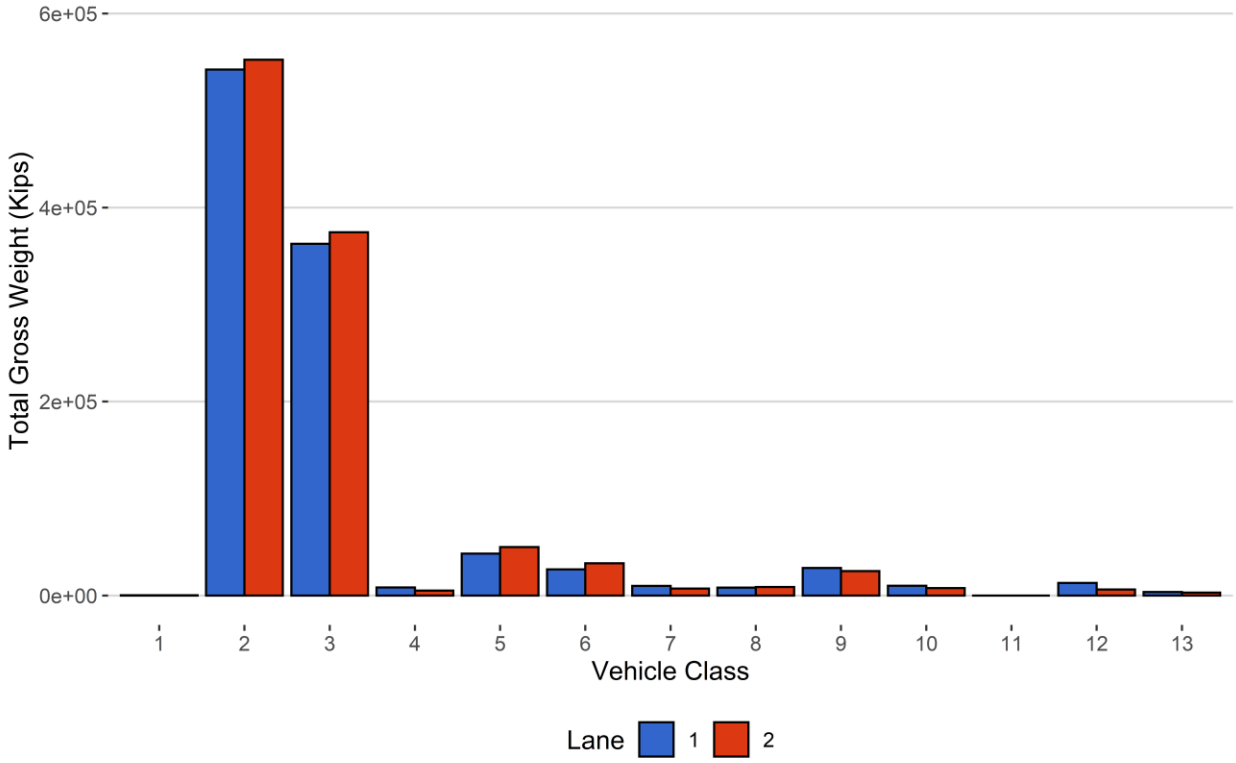


Figure 11 - Total Gross Vehicle Weight

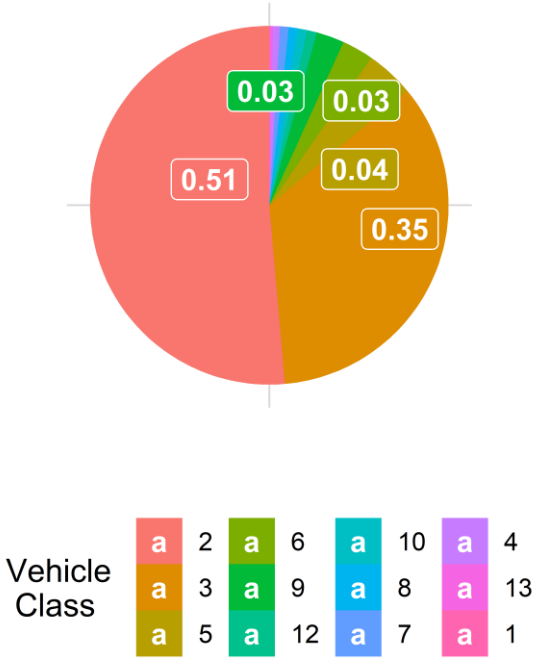


Figure 12 - Total ESALs by Class and Lane

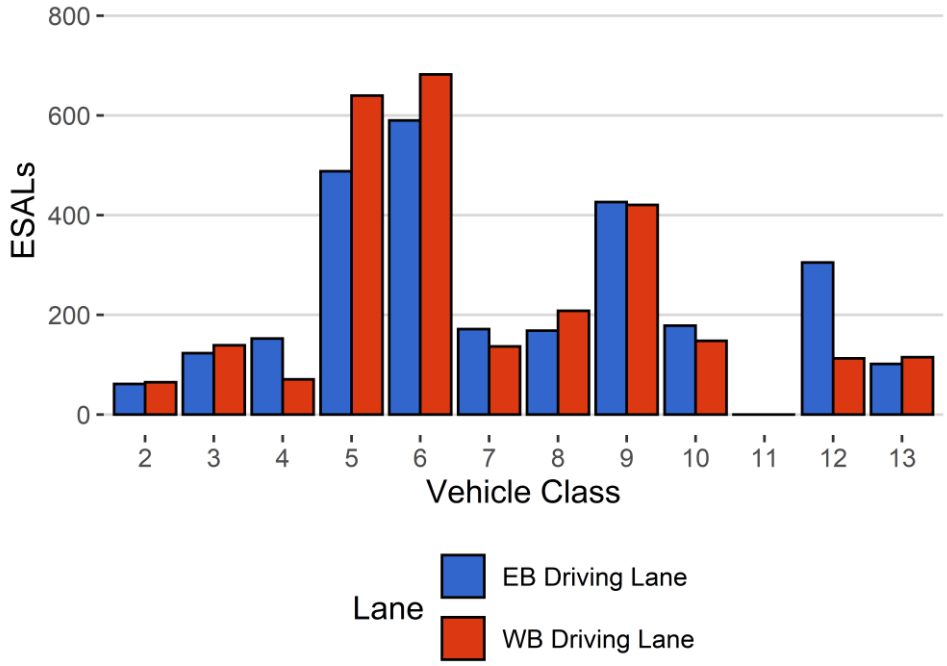
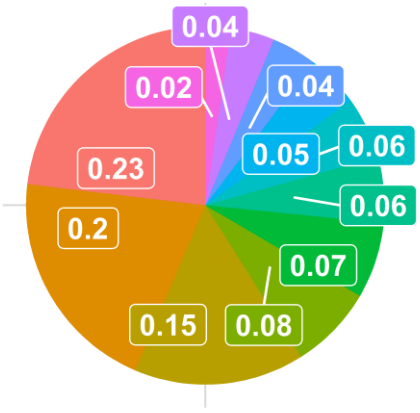


Figure 13 - ESALs by Class



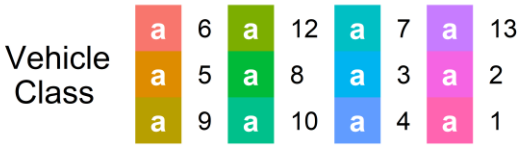


Table 1 Class 9 Front Axle Weight by Lane

Month	*Lane 1 (Kips)*	*Front Axle +/- 9%*	*Lane 2 (Kips)*	*Front Axle +/- 9%*
February 2016	11.29	0.00	10.54	0.00
March 2016	11.21	-0.66	10.73	1.86
April 2016	11.05	-2.13	10.74	1.89
May 2016	10.75	-4.71	10.19	-3.28
June 2016	10.71	-5.12	10.39	-1.38
July 2016	10.72	-5.02	10.36	-1.66
October 2016	10.68	-5.35	10.58	0.39
November 2016	10.87	-3.64	10.46	-0.76
March 2017	11.18	-0.93	10.67	1.29
April 2017	11.29	0.03	10.39	-1.41
May 2017	10.93	-3.13	10.57	0.31
June 2017	10.82	-4.11	10.61	0.71
July 2017	10.93	-3.18	10.65	1.01
August 2017	10.86	-3.76	10.50	-0.39
September 2017	10.74	-4.84	10.55	0.11
October 2017	10.76	-4.66	10.48	-0.58
November 2017	10.72	-5.00	10.41	-1.23
December 2017	10.53	-6.74	10.36	-1.74
January 2018	11.18	-0.95	10.56	0.22
February 2018	11.38	0.81	10.80	2.44
March 2018	11.50	1.90	10.88	3.23
April 2018	11.05	-2.07	10.90	3.47
May 2018	10.84	-3.96	10.64	0.98
June 2018	10.79	-4.43	10.44	-0.89
July 2018	10.84	-3.91	10.66	1.15
August 2018	10.92	-3.22	10.83	2.74
September 2018	10.90	-3.41	10.91	3.49
October 2018	11.00	-2.54	10.84	2.90
November 2018	10.83	-4.03	10.65	1.04
December 2018	10.97	-2.76	10.86	3.08
January 2019	10.95	-2.96	10.93	3.69
February 2019	11.27	-0.11	10.94	3.80
March 2019	11.33	0.37	11.27	6.95
April 2019	11.06	-1.97	11.26	6.80
May 2019	10.96	-2.85	11.05	4.82
June 2019	11.06	-2.00	10.90	3.46
July 2019	11.05	-2.10	10.84	2.90
August 2019	10.99	-2.62	11.06	4.96

Table 2 Vehicle Classification Data

Vehicle Class	*Monthly Average Daily Volume*	*Monthly Total Volume*	*Monthly Total Volume Percentage*	*Monthly Total Overweight Vehicles*	*Monthly Total Overweight Percentage*
1	14	426	0.1	0	0
2	9089	281758	67.6	0	0
3	3979	123336	29.6	0	0
4	16	482	0.1	26	2.8
5	209	6487	1.6	90	9.7
6	54	1668	0.4	168	18
7	9	274	0.1	126	13.5
8	17	517	0.1	63	6.8
9	33	1036	0.2	155	16.6
10	9	264	0.1	109	11.7
11	0	0	0	0	0
12	8	253	0.1	148	15.9
13	2	65	0	47	5
TOTAL	**13438**	**416566**	**100**	**932**	**100**

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2019-08-19	Monday	17:10:58	10	WB	2	130.06
2019-08-01	Thursday	09:40:33	10	WB	2	124.31
2019-08-12	Monday	06:36:39	10	EB	1	109
2019-08-23	Friday	17:56:36	10	EB	1	108.8
2019-08-29	Thursday	20:06:05	10	EB	1	105.11
2019-08-27	Tuesday	13:22:20	10	WB	2	105.07
2019-08-27	Tuesday	15:34:06	10	WB	2	103.5
2019-08-14	Wednesday	18:21:17	10	WB	2	100.08
2019-08-01	Thursday	10:52:59	10	EB	1	98.36
2019-08-14	Wednesday	12:30:16	10	WB	2	98.26

Table 4 Freight Summary

Vehicle Class	*Direction*	*Weight of Empty Vehicle (Kips)*	*Total Number of Vehicles*	*Number of Empty Vehicles*	*Percentage of Empty Vehicles*	*Total Weight of Vehicles with Freight (Kips)*	*Total Weight of Empty Vehicles (Kips)*	*Total Weight of Freight (Tons)*
4	EB	15	277	40	14.4	7697	524	2071
5	EB	8	3017	265	8.8	41315	1924	9650
6	EB	19	732	8	1.1	26837	142	6540
7	EB	11.5	164	0	0	9887	0	4000
8	EB	31	249	105	42.2	6351	1857	944
9	EB	33	564	42	7.4	27044	1310	4909
10	EB	33.5	150	7	4.7	9882	192	2546
12	EB	36.5	171	0	0	12948	0	3353
13	EB	31.5	37	0	0	3585	0	1210
TOTAL	****	****	**5361**	**467**	****	**145546**	****	**35223**
Vehicle Class	Direction	Weight of Empty Vehicle (Kips)	Total Number of Vehicles	Number of Empty Vehicles	Percentage of Empty Vehicles	Total Weight of Vehicles with Freight (Kips)	Total Weight of Empty Vehicles (Kips)	Total Weight of Freight (Tons)
4	WB	15	202	24	11.9	4816	319	1073
5	WB	8	3425	223	6.5	48350	1576	11367
6	WB	19	925	6	0.6	33166	100	7852
7	WB	11.5	108	0	0	7122	0	2940
8	WB	31	264	129	48.9	6304	2516	1059
9	WB	33	465	22	4.7	24488	660	4934
10	WB	33.5	112	3	2.7	7571	65	1960
12	WB	36.5	80	0	0	6176	0	1628
13	WB	31.5	28	0	0	2949	0	1034
TOTAL	****	****	**5609**	**407**	****	**140941**	****	**33847**
GRAND TOTAL	****	****	**10970**	**874**	**154**	**286487**	**11185**	**69070**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*EB*	*WB*	*Total*	*Percentage*
1	256	194	450	0
2	542271	552439	1094709	51.4
3	362700	374613	737313	34.6
4	8221	5135	13356	0.6
5	43239	49925	93164	4.4
6	26979	33265	60244	2.8
7	9887	7122	17009	0.8
8	8208	8820	17028	0.8
9	28354	25148	53502	2.5
10	10074	7636	17710	0.8
12	12948	6176	19124	0.9
13	3585	2949	6534	0.3
TOTAL	**1056723**	**1073421**	**2130144**	**100**
GVW/LANE	**49.61**	**50.39**	**100**	**0**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	*EB*	*WB*	*Total*	*Percentage*	*Flexible ESAL Factor*
1	0	0	0	0	0.0024
2	62	65	126	2.3	9e-04
3	123	139	262	4.8	0.0043
4	152	71	223	4	0.94
5	488	640	1128	20.5	0.35
6	590	682	1272	23.1	1.55
7	171	137	308	5.6	2.26
8	168	208	377	6.8	1.47
9	426	420	847	15.4	1.66
10	179	148	327	5.9	2.46
12	305	113	418	7.6	3.25
13	102	115	217	3.9	5.78
TOTAL	**2768**	**2738**	**5506**	**100**	**20**
ESALS/LANE	**50.3**	**49.7**	**100**	**–**	**–**

Table 7 Site Summary: Volume and Vehicle Class

Month	*Total Volume*	*Monthly ADT*	*Monthly HCADT*	*Passenger Vehicles*	*Passenger Vehicles %*	*Heavy Commercial Vehicles*	*Heavy Commercial Vehicles %*
Sep 2018	419706	13990	419	407143	97	12563.1	3
Oct 2018	444856	14350	511	429029	96.4	15827.1	3.6
Nov 2018	398210	13274	359	387448	97.3	10761.7	2.7
Dec 2018	387498	12500	313	377791	97.5	9706.9	2.5
Jan 2019	367731	11862	300	358419	97.5	9311.5	2.5
Feb 2019	343809	12279	328	334638	97.3	9170.8	2.7
Mar 2019	385777	12444	286	376903	97.7	8874.2	2.3
Apr 2019	420217	14007	355	409564	97.5	10653.3	2.5
May 2019	484371	15469	467	469906	97	14465.4	3
Jun 2019	447421	14914	380	436036	97.5	11385.3	2.5
Jul 2019	404321	12901	335	393924	97.4	10396.9	2.6
Aug 2019	416566	13437	356	405520	97.3	11045.9	2.7
TOTAL	**4920483**	**–**	**–**	**4786321**	**–**	**134162**	**–**
AVERAGE	**410040**	**13452**	**367**	**398860**	**97**	**11180**	**3**

###ESALs

Month	*ESALS EB Driving Lane*	*ESALS WB Driving Lane*	*Total ESALS*	*Pavement Life Decrease Months*
Sep 2018	2874	2745	5619	4.4
Oct 2018	4012	4294	8306	7.2
Nov 2018	2509	2284	4793	3.1
Dec 2018	2365	2179	4544	1.6
Jan 2019	2057	1877	3933	1.3
Feb 2019	2201	2100	4301	1.1
Mar 2019	2197	1698	3894	2.1
Apr 2019	2374	2514	4888	15.4
May 2019	3494	3224	6717	4.3
Jun 2019	6067	4480	10547	6.4
Jul 2019	3071	1861	4932	4
Aug 2019	2786	2746	5532	3.7
TOTAL	**36005**	**–**	**–**	**–**
AVERAGE	**3000**	**2667**	**5667**	**5**

###Gross Vehicle Weight

Month	*GVW EB Driving Lane*	*GVW WB Driving Lane*	*Total GVW Kips*
Sep 18	1098955	1038371	2137326
Oct 18	1261947	1190018	2451966

Nov 18	1022767	962848	1985615
Dec 18	996068	942253	1938320
Jan 19	928842	879765	1808607
Feb 19	893522	831150	1724672
Mar 19	1002496	848116	1850612
Apr 19	1090589	993366	2083955
May 19	1300770	1199019	2499789
Jun 19	2470166	2048533	4518699
Jul 19	1170043	874938	2044980
Aug 19	1057506	1074847	2132353
TOTAL	**14293672**	**12883222**	**27176895**
AVERAGE	**1191139**	**1073602**	**2264741**

###Overweight Vehicles

Month	*Total Number of Overweight Vehicles*	*Overweight / Total Volume*	*Overweight / Heavy Commercial Volume*	*Number Over 88,000 lbs*	*Number Over 98,000 lbs*
Sep 2018	745	0.2	5.8	82	35
Oct 2018	1310	0.3	7.8	148	66
Nov 2018	615	0.2	5.6	48	16
Dec 2018	693	0.2	7	37	13
Jan 2019	492	0.1	5.2	20	8
Feb 2019	553	0.2	5.9	27	11
Mar 2019	470	0.1	5.1	34	10
Apr 2019	638	0.2	5.8	95	16
May 2019	999	0.2	6.8	66	20
Jun 2019	1566	0.2	6.8	172	54
Jul 2019	761	0.2	7.2	76	32
Aug 2019	939	0.2	8.4	86	37
TOTAL	**9781**	**–**	**–**	**891**	**318**
AVERAGE	**815.1**	**0.2**	**6.5**	**74.2**	**26.5**

###Freight

Month	*EB Freight Tons*	*WB Freight Tons*	*Total Freight*	*EB Freight %*	*WB Freight %*
Sep 2018	37861	34874	72735	52.1	47.9
Oct 2018	52534	62656	115190	45.6	54.4
Nov 2018	32474	29307	61781	52.6	47.4
Dec 2018	31218	27144	58362	53.5	46.5
Jan 2019	25566	23173	48739	52.5	47.5
Feb 2019	25807	22634	48441	53.3	46.7

Mar 2019	26399	20405	46803	56.4	43.6
Apr 2019	30513	29739	60251	50.6	49.4
May 2019	45606	43096	88702	51.4	48.6
Jun 2019	76795	58724	135519	56.7	43.3
Jul 2019	39281	23158	62440	62.9	37.1
Aug 2019	35223	33847	69070	51	49
TOTAL	**459277**	**408756**	**868033**	**–**	**–**
AVERAGE	**38273.1**	**34063**	**72336.1**	**53.2**	**46.8**